REMARKS

Claims 1-19 are pending in the application.

Claims 1-18 have been amended in order to more particularly point out, and distinctly claim the subject matter to which the applicant regards as his invention. It is believed that this Amendment is fully responsive to the Office Action dated **December 19, 2002**.

The specification has been objected to due to certain informalities, which the Examiner deemed needed correction, as set forth in item 2, page 2 of the outstanding Action.

Applicant respectfully submits that the amendments to the specification obviates the objection to the specification. Accordingly, withdrawal of the objection to the specification is respectfully solicited.

In view of the aforementioned amendments and accompanying remarks, claims 1-18, as amended, are in condition for allowance, which action, at an early date, is requested.

Objections to the Drawings:

A Request for Approval of Drawing changes is being filed concurrently herewith. Reconsideration and withdrawal of this objection are respectfully requested.

Objection to the Specification:

The specification has been amended, per suggestion of the Office. Reconsideration and withdrawal of this objection is respectfully requested.

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Claim Rejections under 35 USC §112

Claims 1-18 are rejected under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The claims are amended, as needed, to overcome this rejection. The Office suggestions are noted with appreciation. Reconsideration and withdrawal of this rejection are respectfully requested.

Claim Rejections under 35 USC §103

Claims 1, 4, 5 and 8-13 are rejected under 35 USC §103(a) as being unpatentable over Kadokura et al. (U.S. Patent No. 4,842,708) in view of Scherer et al. (U.S. Patent No. 4,931,169) and further in view of Kadokura et al. (U.S. Patent No. 4,784,739) (Kadokura II).

The present invention relates to an improvement of the conventional facing-targets sputtering apparatus which was proposed in Kadokura, Kadokura II and others, and the conventional equipment, as mentioned in the specification, has a problem that the quality of the previously formed film, such as an organic material film, is impaired when a film is formed on a film that has been formed previously, and a problem that forming a thin film under high vacuum, which is necessary in the formation of advanced thin films, is difficult, and the objects of the present invention are to solve these problems, providing a sputtering method for forming a metal film of uniform thickness and high quality, and providing a sputtering method capable of forming a film under high vacuum, and providing a sputtering method allowing wide-range adjustment of

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discharge voltage for sputtering and, particularly, capable of forming a film stably even at low discharge voltage. Concerning item 24 of the Office Action, the Office finds that Kadokura discloses the pressure can be $1x10^{-6}$ Torr (Example 1) , but the pressure of $1x10^{-6}$ Torr is the pressure at preparation process where sputtering can not be carried out.

And the present invention finds out that these problems can be solved when direct-current power and high-frequency power are both applied to the paired targets in the facing-targets sputtering apparatus provided with an electron reflection means. These phenomena are fully explained with Experiment 1 and Comparative Experiment in the specification referring the graphs illustrated in Figures 5 and 6 which show the effect, and it becomes clear especially from comparison of the both figures that the effect of the DC + HF power cannot be obtained even in the facing-targets sputtering apparatus if the electron reflective means is not provided in it, the effect can be realized only if the electron reflective means is equipped. The present invention is accomplished based on the discovery of the effect, and therefore is distinguished by the combination of the electron reflective means and DC + HF power supply.

On the other hand, the conventional facing-targets sputtering apparatus, which is the object for improvement of this invention is indicated, as pointed out by the examiner, in the cited Kadokura and Kadokura, II. However, the problems brought forward by the present invention are not mentioned in these documents, therefore, naturally the feature of the present invention, that is, the combination of the electron reflective means and DC + HF power supply is not described in them, either.

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The cited Scherer, relating to forming a dielectric layer in a substrate, is made to solve problems of falling of film forming rate caused by the charge on the target in the magnetron sputtering apparatus and of flashover occurring, and as indicated by the examiner, applying DC + AC power in the sputtering apparatus is mentioned in the document. However, there is neither description about facing-targets sputtering apparatus, nor mentioning the formation of a film without damaging the previously formed film brought forward by the present invention, and adjusting sputtering voltage for the aforementioned purpose.

As mentioned above, the present invention is completed to solve newly brought problems which are not mentioned in any of cited documents, and it is accomplished based on the discovery of the effect of allowing wide-range adjustment of sputtering voltage and also capable of forming a film by sputtering under high vacuum which is achieved with the combination of an electron reflective means and DC + HF electric power but is not mentioned in any of the cited documents. Therefore, it is clear the present invention is not obvious from the descriptions in the cited documents.

Furthermore, there is no technical suggestion to combine by Kadokura and Kadokura, II with Scherer, because Kadokura and Kadokura, II disclose only traditional facing-targets sputtering apparatus, and on the other hand, Scherer only discloses using DC + AC power supply to disturb the charge effect caused when forming a dielectric film in magnetron sputtering apparatus whose construction is clearly different from a facing-targets sputtering apparatus. From this point of view, it is also clear that the t invention is not obvious from the cited documents.

Section 2143 of the MPEP has specifically stated that:

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> "To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference must teach or suggest all the claimed limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 466, 20 USPQ2d 1438 (Fed. Cir. 1991)."

Therefore, it is both a court position and a Patent Office position that to establish a *prima facie* case of obviousness, 1) there **must be** some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings; 2) there **must be** a reasonable expectation of success; and 3) the teaching or suggestion to make the claimed combination and the reasonable expectation of success **must both be** found in the prior art, and not based on applicant's disclosure.

Should the Office finds other prior art references but is either unable to identify each and every aspect of the above-mentioned claimed features therein, or the formulated rejection simply would not rise to a level objectively fulfilling all three criteria of establishing a *prima facie* case of obviousness, it is respectfully submitted that the obviousness rejection would be defective and allowance of the claimed invention is requested.

Allowable Subject Matter

The early indication of allowable subject matter in claims 2-3, 6-7 and 14-18 is noted with appreciation.

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Conclusion

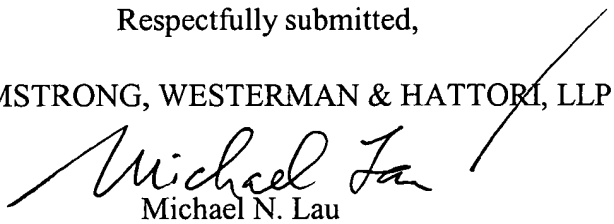
If, for any reason, it is felt that this application is not now in condition for allowance, the Examiner is requested to contact Applicant's undersigned attorney at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "**Version with markings to show changes made**."

In the event that this paper is not timely filed, Applicant respectfully petitions for an appropriate extension of time. Please charge any fees for such an extension of time and any other fees which may be due with respect to this paper, to Deposit Account No. 01-2340.

Respectfully submitted,

ARMSTRONG, WESTERMAN & HATTORI, LLP



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PATENT TRADEMARK OFFICE

Enclosures: Version with markings to show changes made
Request for Approval of Drawing Corrections w/Fig. 2B marked in red ink

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VERSION WITH MARKINGS TO SHOW CHANGES MADE 09/998,235

IN THE DRAWINGS:

Please amend Fig. 2B as indicated in the attached Request for Approval of Drawing Changes.

IN THE SPECIFICATION:

Page 8, paragraph bridging over to page 9, has been amended as indicated below:

However, the above-mentioned facing-targets-type sputtering method has been found to involve the following problem. When a film is formed on a film that has been formed previously, the quality of the [previousely] previously formed film is impaired in some cases ,for example the case which the [previousely] previously formed film is an organic material. An investigation as to the cause of the impairment revealed that a sputtering voltage; i.e., a discharge voltage, is responsible. An increase in discharge voltage increases kinetic energy of recoiled gas particles and the strength of an accelerating electric field for negative ions in a cathode sheath. The accelerating electric field in a cathode sheath brings about disturbance on a process of arranging sputtered particles on deposition surface when the deposited film consists of organic materials or oxides, or involves rare earth elements. A discharge voltage depends on, for example, a gas pressure and the mechanical layout of target units. Since, for example, a change in gas pressure influences the quality of a formed film, the adjustment of the discharge voltage has been difficult.

Page 11, paragraph bridging over to page 12, has been amended as indicated below:

To achieve the aforementioned objects, the present invention also provides a facing-targets-type sputtering method [comprizes] comprises (a)generating, between a pair of facing targets disposed a predetermined distance away from each other, a magnetic field extending from one target to the other in such a manner as to surround a discharge space provided between the paired targets, to thereby confine plasma within the discharge space by means of the magnetic field; and(b) performing sputtering under vacuum so as to form a film on a substrate disposed at a position beside the discharge space, wherein electrons are caused to be reflected into the discharge space by use of electron reflection means disposed around the corresponding targets, and power generated through superposition of high-frequency power to direct-current power is applied to the targets to effect the sputtering.

Page 13, paragraph bridging over to page 14, has been amended as indicated below:

Notably, the present invention is preferably applied to formation of a metal film, particularly a Cu film, a Cu alloy film, an Al film, or an Al alloy film. Also, the present invention is preferably applied to formation of a wiring film on a semiconductor substrate involving formation of a film on the wall of a very fine hole of high aspect ratio. Preferably, a film is formed under high vacuum at a gas pressure of 0.05 Pa or lower, in view of prevention of such [an] a bad effect of sputtering gas bombarding a formed film surface; i.e., prevention of damage to the interface of a deposited layer. Through employment of a box-type sputtering unit and a sputtering gas pressure of 0.01 Pa or lower as in Experiment 3, the method of the present

invention can form a film on the wall of a very fine hole and is thus favorably applicable to formation of a wiring film on a semiconductor substrate to be used in production of an LSI.

IN THE CLAIMS:

Please amend claims 1-18 as follows:

1. (Amended) A facing-targets[-type] sputtering apparatus for producing a film on a substrate comprising:

a vacuum chamber vessel having two openings formed in two corresponding facing side faces thereof;

a pair of target units disposed so as to cover the corresponding two openings, each unit having a target on a vacuum chamber side;

a substrate holder for holding a substrate disposed at a position beside a discharge space between the targets; and

a power supply unit for supplying direct-current power and high-frequency power to the paired targets,

wherein said paired target units each comprises:

a cooling block for holding the corresponding target on a surface thereof;

magnetic field generation means for generating a magnetic field in such a manner as to surround the discharge space ; and

electron reflection means for reflecting an electron to the discharge space disposed on the magnetic field generation means in such a manner as to surround the corresponding target.

2. (Amended) A facing-targets[-type] sputtering apparatus for producing a film on a substrate comprising:

a box unit having a discharge space provided therein and having at least three openings formed in corresponding three side faces thereof including two facing side faces;

a pair of target units disposed so as to cover the corresponding two facing openings, each unit having a target on the discharge space side;

a substrate holder for holding a substrate in such a manner so as to cause the substrate to face the opening [not covered with said target unit] remained open and be perpendicular to the pair of target units; and

a power supply unit for supplying direct-current power and high-frequency power to the paired targets, wherein said paired target units each comprises:

a cooling block for holding the corresponding target on a surface thereof;

magnetic field generation means for generating a magnetic field in such a manner as to surround the discharge space; and

electron reflection means for reflecting an electron to the discharge space disposed on the magnetic field generation means in such a manner as to surround the corresponding target.

3. (Amended) A facing-targets[-type] sputtering apparatus according to claim 2, wherein said box unit has openings in corresponding six side faces thereof; the side face which opposes

the opening facing said substrate holder is covered with a target unit having a target and a cooling block without the magnetic field generation means and the electron reflection means; and the remaining two openings are covered with corresponding closing units.

4. (Amended) A facing-targets[-type] sputtering method for producing a film on a substrate which comprises:

(a) generating a magnetic field extending between two targets from one target to the other, the targets being disposed a predetermined distance away from each other, in such a manner as to surround a discharge space provided between the [paired] two targets, to thereby confine plasma within the discharge space by means of the magnetic field; and

(b) performing sputtering under vacuum to form a film on a substrate disposed at a position beside the discharge space, wherein

electrons are caused to be reflected into the discharge space by use of electron reflection means disposed around the corresponding targets, and

power generated through superposition of high frequency power to direct current power is applied to the targets to effect the sputtering.

5. (Amended) A facing-targets[-type] sputtering method according to claim 4, wherein in addition to the magnetic field extending between the targets from one target to the other, a circular arc magnetic field is generated at a peripheral edge portion of each target.

6. (Amended) A facing-targets[-type] sputtering method according to claim 4, wherein the side faces of the discharge space is closed except for a side face which faces the substrate.

7. (Amended) A facing-targets[-type] sputtering method according to claim 6, wherein a side face opposite to the side face facing the substrate is closed by a target unit.

8. (Amended) A facing-targets[-type] sputtering method according to claim 4, wherein the electron reflection means and the targets are made of the same material.

9. (Amended) A facing-targets[-type] sputtering method according to Claim 4, wherein the targets are of Cu, a Cu alloy, Al, or an Al alloy.

10. (Amended) A facing-targets[-type] sputtering method according to claim 4, wherein a film is formed at a gas pressure of 0.5 Pa or lower.

11. (Amended) A facing-targets[-type] sputtering method according to claim 9, wherein the film is a conducting film.

12. (Amended) A facing-targets[-type] sputtering method according to claim 11, wherein the film is formed at a gas pressure of 0.05 Pa or lower.

13. (Amended) A facing-targets[-type] sputtering method according to claim 11, wherein the film is a metal film.

14. (Amended) A facing-targets[-type] sputtering method according to claim 4, wherein a sputtering unit comprising the facing targets is a box[-type] sputtering unit configured to close side faces of the discharge space except for a side face facing the substrate; and the film is formed at a gas pressure of 0.01 Pa or lower.

15. (Amended) A facing-targets[-type] sputtering method according to claim 14, wherein a side face opposite to the side face facing the substrate is closed by a target unit.

16. (Amended) A facing-targets[-type] sputtering method according to claim 14, wherein the film is a metal film.

17. (Amended) A facing-targets[-type] sputtering method according to claim 16, wherein the film is a wiring film of a semiconductor device.

18. (Amended) A facing-targets[-type] sputtering method according to Claim 15, wherein the [metal] film are of Cu, a Cu alloy, Al, or an Al alloy.

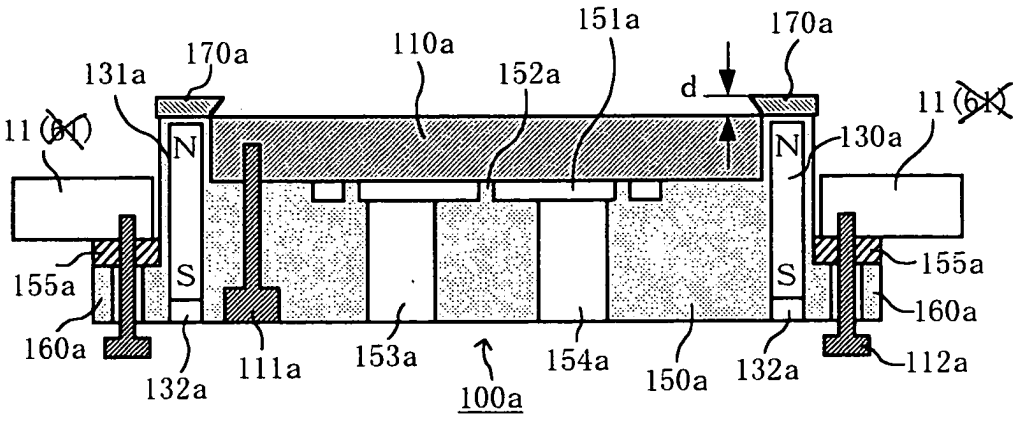

Fig. 2B

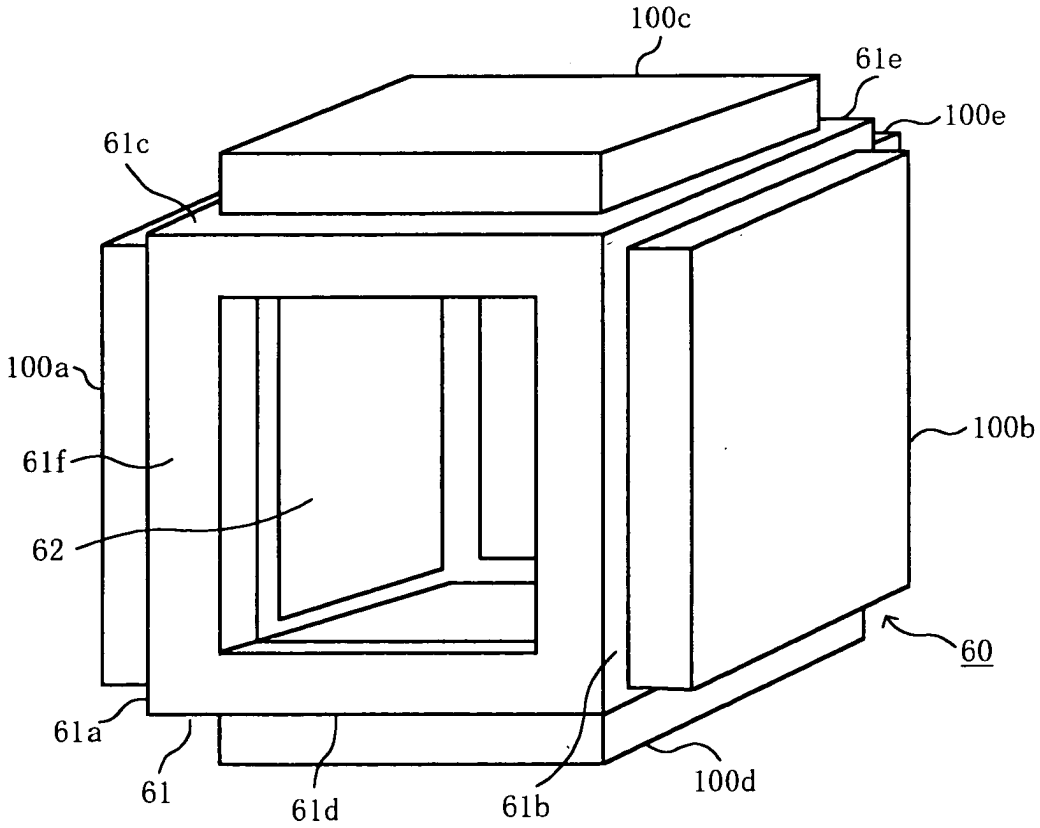

Fig. 3